

**AFRL-SN-WP-TM-2003-1089**

**AFRL/GaAsTek HETEROJUNCTION  
BIPOLAR TRANSISTOR (HBT)  
PROCESS DEVELOPMENT**

**ITT GaAsTek  
5310 Valley Park Drive  
Roanoke, VA 24019**



**James K. Gillespie  
Electron Devices Branch (AFRL/SNDD)  
Aerospace Components and Subsystems Technology Division  
Sensors Directorate  
Air Force Research Laboratory, Air Force Materiel Command  
Wright-Patterson Air Force Base, OH 45433-7318**

**OCTOBER 2001**

**Final Report for 01 March 1999 – 01 September 1999**

**Approved for public release; distribution is unlimited.**

**20030624 029**

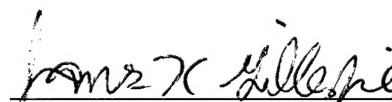
**SENSORS DIRECTORATE  
AIR FORCE RESEARCH LABORATORY  
AIR FORCE MATERIEL COMMAND  
WRIGHT-PATTERSON AIR FORCE BASE, OH 45433-7318**


## NOTICE


Using government drawings, specifications, or other data included in this document for any purpose other than government procurement does not in any way obligate the U.S. Government. The fact that the government formulated or supplied the drawings, specifications, or other data does not license the holder or any other person or corporation; or convey and rights or permission to manufacture, use, or sell any patented invention that may relate to them.

This report has been reviewed by the Office of Public Affairs (ASC/PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

  
JAMES K. GILLESPIE, Project Engineer  
Electron Devices Branch  
Aerospace Components Division

  
KENICHI NAKANO, Chief  
Electron Devices Branch  
Aerospace Components Division

  
ROBERT T. KEMERLEY, Chief  
Aerospace Components Division  
Sensors Directorate

Copies of this report should not be returned unless return is required by security considerations, contractual obligations, or notice on a specific document.

<b>REPORT DOCUMENTATION PAGE</b>					Form Approved OMB No. 0704-0188	
The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. <b>PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.</b>						
<b>1. REPORT DATE (DD-MM-YY)</b> October 2001		<b>2. REPORT TYPE</b> Final		<b>3. DATES COVERED (From - To)</b> 03/01/1999 – 09/01/1999		
<b>4. TITLE AND SUBTITLE</b> AFRL/GaAsTek HETEROJUNCTION BIPOLAR TRANSISTOR (HBT) PROCESS DEVELOPMENT				<b>5a. CONTRACT NUMBER</b> N/A		
				<b>5b. GRANT NUMBER</b>		
				<b>5c. PROGRAM ELEMENT NUMBER</b> 62204F		
<b>6. AUTHOR(S)</b> James K. Gillespie (AFRL/SNDD)				<b>5d. PROJECT NUMBER</b> 6096		
				<b>5e. TASK NUMBER</b> 11		
				<b>5f. WORK UNIT NUMBER</b> 63		
<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b> ITT GaAsTek 5310 Valley Park Drive Roanoke, VA 24019 Electron Devices Branch (AFRL/SNDD) Aerospace Components and Subsystems Technology Division Sensors Directorate Air Force Research Laboratory, Air Force Materiel Command Wright-Patterson Air Force Base, OH 45433-7318				<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b>		
<b>9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b> Sensors Directorate Air Force Research Laboratory Air Force Materiel Command Wright-Patterson AFB, OH 45433-7318				<b>10. SPONSORING/MONITORING AGENCY ACRONYM(S)</b> AFRL/SNDD		
				<b>11. SPONSORING/MONITORING AGENCY REPORT NUMBER(S)</b> AFRL-SN-WP-TM-2003-1089		
<b>12. DISTRIBUTION/AVAILABILITY STATEMENT</b> Approved for public release; distribution is unlimited.						
<b>13. SUPPLEMENTARY NOTES</b>						
<b>14. ABSTRACT</b> A CRDA was established between Aerospace Components and Subsystem Division (AFRL/SND) and ITT GaAsTek to transfer the design, manufacture, and development of the Air Force's thermally shunted HBT (TSHBT) process to GaAsTek and to co-develop, design, and fabricate novel power amplifiers using GaAsTek's Process 5 MMIC foundry. GaAsTek was a well-known DoD MMIC foundry for high-power x-band amplifiers utilizing MESFET technology. AFRL/SND was known for developing a TSHBT capability for high power density devices. By working together, plans were made to transfer the TSHBT technology to GaAsTek. The Air Force was to benefit from this transfer by having a reputable DoD foundry be capable of manufacturing high-power amplifiers for Air Force system integration. Another added benefit would be having Air Force circuit designers work with a foundry to design and process novel power amplifiers for future Air Force system needs. GaAsTek was to benefit by gaining a new device capability, which could be used for commercial as well as military markets.						
<b>15. SUBJECT TERMS</b> HBT, process development, x-band power transistors						
<b>16. SECURITY CLASSIFICATION OF:</b>			<b>17. LIMITATION OF ABSTRACT:</b> SAR	<b>18. NUMBER OF PAGES</b> 8	<b>19a. NAME OF RESPONSIBLE PERSON (Monitor)</b> James K. Gillespie <b>19b. TELEPHONE NUMBER (Include Area Code)</b> (937) 255-1874 x3459	
<b>a. REPORT</b> Unclassified	<b>b. ABSTRACT</b> Unclassified	<b>c. THIS PAGE</b> Unclassified				

Final Report

**AFRL/GaAsTek HBT Process Development**

**Introduction**

A CRDA was established between Aerospace Components and Subsystem Division (AFRL/SND) and ITT GaAsTek to transfer the design, manufacture, and development of the Air Forces thermally shunted HBT (TSHBT) process to GaAsTek and to co develop, design and fabricate novel power amplifiers using GaAsTek's Process 5 MMIC foundry. GaAsTek was a well-known DOD MMIC foundry for high power x-band amplifiers utilizing MESFET technology. AFRL/SND was known for developing a TSHBT capability for high power density devices. By working together plans were made to transfer the TSHBT technology to GaAsTek. The Air Force was to benefit from this transfer by having a reputable DoD foundry be capable of manufacturing high power amplifiers for Air Force system integration. Another added benefit would be having Air Force circuit designers work with a foundry to design and process novel power amplifiers for future Air Force system needs. GaAsTek was to benefit by gaining a new device capability, which could be used for commercial as well as military markets.

**Discussion**

AFRL/SND hosted three GaAsTek process engineers for one week to demonstrate all aspects of the TSHBT process. Wafers were prepared ahead of time in order to be ready for each step of the process prior to their arrival in order to fully demonstrate these process steps. During this week long visit GaAsTek employees were able to see first hand each step of the high power TSHBT process developed at AFRL/SND. With the completion of the weeklong training, GaAsTek purchased wafers and processes were begun at their facility. All process documentation and test data from previously processed wafers were supplied to GaAsTek. In support of the transition SND engineers were available through phone conversations and email to help answer questions and review data.

When GaAsTek had completed the first lot of wafers at their facility three SND engineers traveled to visit their foundry. This reason for this visit was two fold. 1. help GaAsTek perfect a critical process step utilizing their facility and equipment, and 2. tour their MMIC foundry to determine which GaAsTek processes could be interchanged and still be able to complete the transfer. The critical process step was reviewed and the technique was fully understood by GaAsTek engineers during this visit. Existing GaAsTek processes were also considered as alternative approaches and advice given for implementation. While there, discussions took place as to the logistics of training Air Force engineers for designing into their foundry. Points of contact were exchanged and timelines discussed for this phase of the effort.

Shortly after the visit GaAsTek was purchased by M/A-COM Associates. With this change of leadership at GaAsTek came a shift in priorities within the engineering staff.

More focus was put on existing processes and products. Although GaAsTek was ready to fulfill the design and process portion of the agreement, AFRL/SND decided to not participate in this phase.

### **Conclusions**

The main objective of this agreement was to transfer the Air Force's TSHBT process to ITT GaAsTek. This transfer would give high power device technology to a commercial DoD MMIC foundry. The transfer took place by training device process engineers at SND, phone and email exchanges and traveling to GaAsTek for follow on training. GaAsTek was able to build working TSHBT devices at their facility. This collaboration came to a conclusion when the company was purchased by M/A-COM. The change of leadership caused more emphasis to be put on existing technologies. With less emphasis put on the development of the TSHBT process, AFRL/SND slowly reduced the amount of effort in the transfer.